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Combined Nitrogen Washout Maneuver

Collins GEM/Owl-Hawk-Eagle Series Users Manual Addendum

Introduction:

The Collins GEM/Owl-Hawk series devices represent a family of flow-based pulmonary function testing instruments, all based on the standard Collins GEM chassis. Both provide direct spirometry, maximum/minimum pulmonary pressure measurement capability, and single-breath diffusing capacity measurement capability. The Owl is designed specifically as a single-breath diffusing capacity measurement add-on device to the Collins BP^D Body Plethysmograph device, enabling the performance of diffusing capacity testing from with the BP+ body box. The Hawk is provides the same measurement capabilities provided by the Owl, but is marketed as a free-standing flow-based pulmonary measurement system. The addition of the Eagle to this family of devices adds the capability of measuring lung volumes by means of the multi-breath Nitrogen (N2) washout technique, in which the test subject breaths 100% Oxygen (O2) as delivered and measured by the Eagle device until the %N2 value falls below a target value, typically a value in the range of 1 – 3%.

All measurement capabilities of the Eagle remain the same as for the Owl and Hawk, with the exception of the addition of N2 washout lung volume testing. This addendum to the Owl/Hawk Users Manual, details the N2 calibration procedure, the N2 test setup, and performance of the N2 washout test itself. All other information in the Owl/Hawk Users Manual remains unchanged.

N_2 Calibration:

1. From the main Plus2k screen, click on Tools/Calibration on the top Window's® menu.
2. The GEM Eagle device installed on your system should be listed as an available USB testing device. (It will be listed as: GEM (S/N xxxx), where xxxx is the device serial number, rather than specifically as 'Eagle'.) Click on the '+' sign in front of the Eagle entry. A list of the Eagle test devices will be displayed.
3. Ensure that the Oxygen, Diffusion gas test mixture, and the N_2 calibration gas mixture (5.00% Carbon Dioxide (CO_2), 15.00 Oxygen (O_2)) are installed on the system and that they contain adequate amounts of gas for calibration and testing.
4. Perform the PB and Temp, Pneumotach, MGA Analyzer, and N_2 Analyzer calibrations. (Mouth pressure calibration is not needed for lung volume testing.) See the calibration section of the manual for instructions on performing the BP/Temp, Pneumotach, and MGA Analyzer calibrations.
5. Follow the prompts displayed on the screen during calibration. Once started, all aspects of the N_2 analyzer calibration proceed automatically.

6. When all calibrations have been successfully completed and the results saved to the database, print a copy of the current calibration values for your daily QC records as appropriate for your laboratory.
7. The Eagle is now ready to perform testing.

N2 Test Setup:

1. Create a new patient study record, or select a patient from the Patient Cache, as the current test subject.
2. Click on GoTo/Lung volumes (N_2), to select the N_2 washout testing program.
3. When the N2 testing screen displays, click on 'Start Test', and then click on the desired test type from the options displayed in the drop-down menu: Combined, which measures the Slow Vital Capacity (SVC) and the Functional Residual Capacity (FRC) during the same test maneuver, 'Lung volumes', which measures and reports the FRC only, or SVC, which measures and reports only direct spirometry lung volumes.
4. The system will be set up for performing the requested measurements. (In general, no user interaction is required with the exception that during certain test set up procedures, the operator will be prompted to insure that there is no flow through the Pneumotach and then press the spacebar. This step enables the program to internally set the required baseline flow conditions.) When set up is complete, a dialog will prompt the operator to connect the test subject to the system, and to press the space bar to begin data collection.

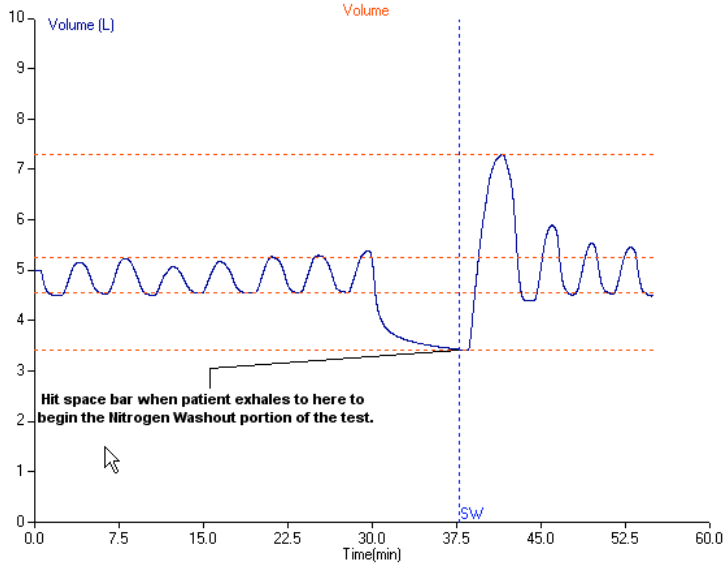
Performing the Combined N_2 Washout Lung Volume Test:

Note: Collins recommends the use of the Combined SVC and FRC test maneuvers, rather than performing isolated lung volume and/or SVC tests. The combined maneuver provides complete data for all parameters, making it easy to reconcile differences between test efforts, correlation of parameters for internal quality control purposes, and troubleshooting of questionable test results possible.

1. When test set up is completed, and the test subject is connected to the system with a nose-clip in place, prompt them to just breathe normally. When their breathing pattern is stable and they and they appear settled and comfortable, press the spacebar to initiate data collection. Tidal breathing, displayed as volume on the 'Y'-axis vs 'Time' on the 'X'-axis, will be displayed. When the configured number of breaths has been collected, the end-tidal level has been established, a dashed line indicating the end-tidal level will be displayed. On the next breath, as the subject exhales, prompt them to continue exhaling until they have forced as much air out of their lungs as they can. Prompt them to "keep pushing, squeeze every last drop of air out, don't take a breath in until I tell you, when you can't possibly push another drop of air out, signal me by raising your hand." When the subject signals, press the spacebar, then tell them to "take in a deep breath, as deep as you possibly can, until your lungs are as completely filled as you can get

them." (This completes the SVC maneuver and begins the nitrogen washout lung volume measurement with the subject exhaled out to RV.)

(See diagram of volume history below.)



2. After the subject has inspired to Total Lung Capacity (TLC), have them go back to normal relaxed tidal breathing, until the %N2 value falls below the configured target end-of-test value. (If, under Tools/Configuration Editor, the 'Manual End of Test' parameter is set to false on the 'N_2 Washout' tab, the test will automatically terminate when three (3) successive %N_2 values less than the configured 'End of Test %N_2' value are recorded. If set to 'True', the operator must press the spacebar to terminate the test.
3. Placing the cursor arrow in any of the panes on the review screen and right clicking will display a context menu with options specific to the data and presentation in that pane. Editing and selecting of data follows standard Plus2k editing functions as described in the manual in the review sections of the individual test types.
4. At the completion of the test, follow normal Plus2k procedures as described in the manual to select the individual effort results or the average of two or more efforts to save as the 'Reported' values for reporting.

Lung volumes test:

1. The Lung volume test type option sets up the N2 washout test for measurement of the Functional Residual Capacity (FRC) and the Residual Volume (RV). To perform a FRC only maneuver, click on 'Start Test/Lung volumes'. Test set up for the FRC test begins.
2. When test set up is completed, and the test subject is connected to the system with a nose-clip in place, prompt them to just breathe normally. When their breathing pattern is stable and they and they appear settled and comfortable, press the spacebar to initiate data collection. Tidal breathing, displayed as volume on the 'Y'-axis vs 'Time' on the 'X'-axis, will be displayed. When the configured number of breaths has been collected and the end-tidal level has been established,

a dashed line indicating the end-tidal level will be displayed. After the end-tidal level is established, the subject continues relaxed breathing. On the second breath following the display of the end-tidal marker, the system will turn the subject in when the subject reaches the end-tidal level. Monitor the %N2 value reported at the end of each breath, until the test auto-terminates (or press the spacebar to manually terminate test if 'Manual End of Test is configured to 'true'.) Test will terminate and operator will be left in the review mode.

3. Placing the mouse cursor in a data or graphical data display pane and right clicking will bring up a menu with context sensitive editing and end of test breath selection as for the 'Combined' test option.
4. At the completion of the test, follow normal Plus2k procedures as described in the manual to select the individual effort results or the average of two or more efforts to save as the 'Reported' values for reporting.

SVC test:

1. The Slow Vital Capacity (SVC) test option sets the N_2 program up to measure and report all direct spirometry SVC values. SVC only testing is performed by selecting SVC from the 'Start Test' drop-down list.
2. When test set up is completed, and the test subject is connected to the system with a nose-clip in place, prompt them to just breathe normally. When their breathing pattern is stable and they and they appear settled and comfortable, press the spacebar to initiate data collection. Tidal breathing, displayed as volume on the 'Y'-axis vs 'Time' on the 'X'-axis, will be displayed. When the configured number of breaths has been collected, the end-tidal level has been established, a dashed line indicating the end-tidal level will be displayed.
3. Once the end-tidal level has been detected and marked on the graphical display, prompt the subject to exhale all the way out until their lungs are completely empty, forcing as much air out of their lungs as they possibly can. The speed of the exhale is not critical here: the objective is to force as much air out of their lungs as they possibly can, however fast or slowly they exhale.
4. When the subject's has exhaled out fully to RV, prompt them to inhale as much air as they can possibly force into their lungs. The speed of the exhale and inhale is not critical here: the objective is to inspire as much air as they possibly can, however fast or slowly they inhale.

Note: The inhalation and exhalation can be performed in any order. Some physicians prefer that COPD patients exhale all the way to RV before inhaling to TLC to eliminate trapping caused by the intra-thoracic pressure resulting from inhaling to TLC before exhaling.

5. When the subject has completely filled their lungs, prompt them to return to normal relaxed breathing and press the spacebar to terminate the test.
6. Placing the mouse cursor in a data or graphical data display pane and right clicking will bring up a menu with context sensitive editing and end of test breath selection as for the 'Combined' test option.

7. At the completion of the test, follow normal Plus2k procedures as described in the manual to select the individual effort results or the average of two or more efforts to save as the 'Reported' values for reporting.

Reporting N_2 Washout Lung Volume Results in Final Report:

1. Facilities for reporting N2 lung volume results in final report reside in the Extended final report program and are treated the same as the reporting of the tabular and graphical data for all other test types. Graphs specific to the N2 washout method are listed among the helium and body plethysmography lung volume measurement graphical and tabular data display. See the Extended Final Report Section of the Plus/SQL 2000 System Users Manual for instructions specific to constructing custom final report templates and the reporting of data and graphs for all test types.